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Liquid-Metal Heat Transfer in a Cocurrent-Flow, Double-Pipe Heat Exchanger Is Investigated

An analytical and experimental investigation of liquid-metal heat transfer in cocurrent-flow, double-pipe heat exchangers has been reported. The analysis predicts local and fully-developed heat-transfer coefficients, as well as overall rates of heat transfer.

The results show that: 1) heat-transfer coefficients depend upon the operating conditions of the heat exchanger, and their values can be significantly lower than those corresponding to a uniform-surface-temperature boundary condition, and 2) use of the customary design equation to predict heat-exchanger performance leads to significant errors.

The analysis is an extension of a previous study conducted on a heat-exchanger configuration with a narrow annular space. The present work considers the wide annular-space geometry in which the annular ratio, defined as the ratio of the inner and outer diameters of the annulus, becomes an important parameter.

The construction of a mercury heat-transfer loop and experiments with cocurrent-flow, double-pipe heat-exchanger test sections are described. The heat-exchanger uses mercury as the heat transfer media in both channels.

The experiments have been performed with various double-pipe heat exchanger test sections and the results compared with those predicted in the analysis. Fully-developed overall and individual-channel Nusselt numbers and heat-exchanger efficiencies were determined for various heat-exchanger operating conditions. Successful determination of the fully-developed heat-transfer coefficients were limited to operation

with an annular-side Peclet number of 100 for the various tube-side Peclet numbers. General agreement between the analysis and the experimental results was obtained; differences were due to failure to achieve the idealizations desired in the test-section design.

A new technique for determining values of the fully-developed overall Nusselt number by a measurement of the outside-wall-temperature distribution is also introduced. The technique appears promising because of its relative simplicity and its accuracy compared to other methods of determining values of the overall heat-transfer coefficient. Use of the technique also allows one to determine when the heat transfer is actually fully developed.

The present work demonstrates that many of the usual assumptions concerning heat transfer in heat-exchange devices may not always be justified.

Notes:

1. This information has been reported by Richard L. Merriam in ANL-7056, Argonne National Laboratory, Argonne, Illinois, June 1965. The report is available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Va. 22151; price: \$3.00 (microfiche \$0.65).
2. The report presents a review of the literature, mathematical analysis, experimental apparatus and procedure, and a discussion of the results.
3. This information may be useful to industries dealing with heat transfer, in particular to designers and manufacturers of heat exchangers.

(continued overleaf)

4. Inquiries concerning this report may be directed to:

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Patent status:

Inquiries about obtaining rights for commercial use of this innovation may be made to:

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